How *Anisomorpha* got its stripes?

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Abstract

The significance of the colour pattern in the phasmid genus *Anisomorpha* is discussed in relation to recent hypotheses on the evolution of density dependant aposematism in the desert locust. The biology of *Anisomorpha* species offers several alternative explanations of coloration in these species, such as true aposematism, regarding defensive spray; aposematism as the result of feeding behaviour; and density dependant aposematism.

Key words

Phasmida, Aposematism, *Anisomorpha*, *Schistocerca*, Evolution, Density-dependence, mate protection.

This short communications was prompted by a review article of a similar name (Wilson, 2000) regarding aposematic coloration in the Desert Locust (*Schistocerca gregaria*). Wilson described the work of Sword *et al.* (1999 & 2000), regarding the density morphs of *Schistocerca*. The nymphal stages of *S. gregaria* occur in two morphs; a high-density morph characterized conspicuous yellow and black stripes, and a cryptic green morph at low densities. The well-documented swarming behaviour of *Schistocerca* has long interested biologists due to the economic implications of swarms. The advantage to the high-density phenotype is the yellow and black markings displayed by the nymphs, the function of which has so far remained a mystery. Wilson postulates that they function as a visual signal to aid nymphal aggregation or they function with a thermoregulatory role, or as an aposematic (warning) signal. However, we know that locust nymphs are frequently consumed by many species and there are field observations also documenting predation on high-density dependant phenotypes (Gillet & Gonta, 1978).

Sword (1999), demonstrated that the high-density dependent phenotype in *Schistocerca* could act as a potential warning signal to predators, indicating that nymphs have been feeding on toxic food plants, via a series of experiments using lizards and palatable (non-toxic foodplant-fed) and unpalatable (toxic foodplant-fed), low and high density phenotype locust nymphs. In a subsequent study (Sword *et al.*, 2000) demonstrated that predators could learn from one feeding event, that a nymph of the high-density dependant phenotype is unpalatable, yet the low-density (green) phenotype did not elicit such a response. This indicates that the coloration impacts on the predator resulting in avoidance of the high-density phenotype.

Density dependant colour change has evolved in Lepidoptera and has even been documented in phasmids (Key, 1957). This prompted me to consider the coloration and biology of the phasmid *Anisomorpha buprestoides* (Stoll) (and the related striped species, *A. monstrosa* Hebard, and *A. ferruginea* (Beauvois)). *Anisomorpha buprestoides* is a small species of phasmid from North America, which possesses two longitudinal, contrasting stripes (usually white or pale brown on a dark brown or black background). This prompted the following questions: Have these striped *Anisomorpha* species developed aposematic coloration as a warning of the defensive spray? Is this a warning of potential toxic food plant consumption? Alternatively, is it a result of density dependence?

The ability to produce a defensive spray, effective up to 30 cm away, is obviously a good deterrent against predators. However if an insect with a good defensive ability was not conspicuous to predators the defense is of little use (Sword *et al.*, 2000). The warning coloration/pattern is essential to predator recognition. The selective advantage provided by an obvious pattern and a defense mechanism would allow the genes for this to spread throughout the population.

Did *Anisomorpha* develop the aposematic coloration in response to the consumption of predator toxic food plants, and the defensive spray evolve subsequently? Sword *et al.* (1999 & 2000) have demonstrated that *Schistocerca* congregate on predator toxic food plants in preference to more palatable host plants. The evolutionary sequence of events is unknown, therefore the validity of this hypothesis cannot be assessed. However, insects sporting aposematic coloration and not being toxic are more likely to be found out by predators, therefore non-toxic individuals are likely to be cryptic at low density. This is observed in locusts and certain Lepidoptera (Reeson *et al.*, 1998). It should also be noted that many species of phasmid produce defensive sprays, yet remain cryptic.

Finally, the evolution of density dependant aposematism in stable populations, where the supply of toxic host-foodplants is predictable, would only occur at high population levels (Wilson, 2000). The observation of other aspects of *Anisomorpha* biology would seem to indicate that this group favours high densities of conspecifics. *Anisomorpha* species, especially the nymphal stages, are gregarious. These taxa exhibit social interactions and antagonistic behaviour, such as abdomen tapping in response to conspecifics. In addition, the males of this species mate for extended periods (sometimes throughout life), which would indicate mate protection is occurring. This would be of benefit in high densities (protection) and at low densities (mate finding restrictions), however the gregarious behaviour of *Anisomorpha* is not consistent with the low-density hypothesis.

This short paper has posed more questions than it has answered regarding the evolution and behaviour of this fascinating group of phasmids, hopefully it has stimulated some thought on the subject. It would be interesting to hear any other thoughts on the significance of coloration in a group of insects renowned for their cryptic behaviour.

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